CS100J 24 October 2006

Arrays. Reading: Secs 8.1, 8.2, 8.3.

Listen to the following lectures on loops on your Plive CD. They are only 2-3 minutes long, and each has an insightful message.

1. The three lectures on Lesson page 7-6 —read the whole page.
2. The four lectures in Lesson page 7-5.

Start reading Secs. 8,1, 8.2, and 8.3 on arrays.

Computational simplicity

If you are writing too much code —it gets longer and longer, with no end in sight: **stop and look for a better way**.

If your code is getting convoluted and you have trouble understanding it: **stop and look for a better way**.

Learn to keep things simple, to solve problems in simple ways. This sometimes requires a different way of thinking.

We are trying to teach not just Java but how to think about problem solving.

A key point is to break a problem up into several pieces and do each piece in isolation, without thinking about the rest of them. Our methdology for developing a loop does just that.

Arrays

An array: an object that can hold a fixed number of values of the same type. Array to the right contains 4 **int** values.

	a0
0	5
1	7
2	4
3	-2

The **type** of the array to the right is

int[]

Here is a variable that contains the name of the array.

x $\boxed{a0}$ **int**[]

A declaration has the basic form

<type> <variable-name> ;

A declaration of x looks as to the right. The declaration does not create the array, it only declares x. x's initial value is **null**.

int[] x ;

Elements of the array are numbered 0, 1, 2, …, x.length–1;
length is a variable, not a function, so don't put () after it.

Make everything as simple as possible, but no simpler. Einstein

Arrays

int[] x ;

x $\boxed{null}$ **int**[]

x= **new int**[4];

Create an array object of length 4 and store its name in x

x $\boxed{a0}$ **int**[]

	a0
0	0
1	0
2	0
3	0

x[2]= 5;
x[0]= -4;

Assign 5 to array element 2 and -4 to array element 0

x[2] is a reference to element number 2 of array x

	a0
0	-4
1	0
2	5
3	0

int k= 3;
x[k]= 2* x[0];
x[k-1]= 6;

Assign 2*x[0], i.e. -8, to x[3]
Assign 6 to x[2]

	a0
0	-4
1	0
2	6
3	-8

Difference between Vector and array --both used to contain a bunch of things

Declaration:	**int[]** a;	Vector v;
	Elements of a: **int** values	Elements of v: any Objects
Creation:	a= **new int**[n];	v= **new** Vector();
	Array always has n elements	Number of elements can change
Reference:	a[e]	v.get(e)
Change element:	a[e]= e1;	v.set(e, e1);

Array locations a[0], a[1], a[2] are in successive locations in memory. Access is guaranteed take same, time no matter which one you reference.

Elements are all the same type (a primitive type or some class type)

You can't tell how Vectors are stored in memory. Referencing and changing elements done through method calls

Elements can be of any Object type (but not a primitive type), and casting may be necessary when an element is retrieved.

Array initializers

Instead of

```
int[] c= new int[5];
c[0]= 5; c[1]= 4; c[2]= 7; c[3]= 6; c[4]= 5;
```

Use an array initializer:

```
int[] c= new int[ ] {5, 4, 7, 6, 5};
```

a0
5
4
7
6
5

No expression between the brackets [ ].

array initializer: gives the values to be in the array initially. The values must all have the same type, in this case, **int**. The length of the array is the number of values in the list

Computer science has its field called computational complexity; mine is called computational simplicity. Gries

A use of an array initializer

```
public class D {
   private static final String[] months= new String[]{"January", "February",
                         "March", "April", "May", "June", "July", "August",
                         "September", "October", "November", "December"};

   /** = the month, given its number m
        Precondition: 1 <= m <= 12 */
   public static String theMonth(int m) {
      return months[m–1];
   }
}
```

Note that months[m–1] is returned, since

months[0] = "January",
months[1] is "February",
…

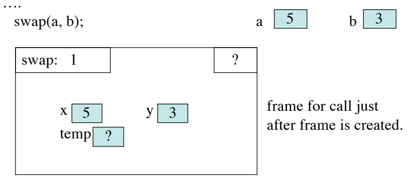
Variable months is:
static so that the object assigned to it will be created only once.
private so that it cannot be seen outside class D.
final so that it cannot be changed

Procedure swap

```
public class D {
   /** = Swap x and y */
   public static void swap (int x; int y) {
      int temp= x;
      x= y;
      y= temp;
   }
}

….
 swap(a, b);
```

The call will NOT swap a and b. Parameters x and y are initialized to the values of a and b, and thereafter, there is no way to change a and b.



frame for call just after frame is created.

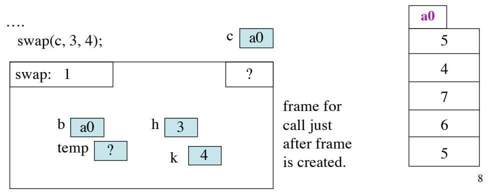
7

Procedure swap

```
public class D {
   /** = Swap b[h] and b[k] */
   public static void swap (int[] b, int h; int k) {
      int temp= b[h];
      b[h]= b[k];
      b[k]= temp;
   }
}

….
 swap(c, 3, 4);
```

This method does swap b[h] and b[k], because parameter b contains the name of the array.



frame for call just after frame is created.

8

Linear search

```
public class D {
   /** = the first occurrence of c in b[h..k-1] —
      = k if c is not in b[h..k-1]*/
   public static void swap (int c, int[] b, int h; int k) {
      int t= h;
      // { invariant: c is not in b[h..t-1] }
      for (t= h; t != k; t= t+1) {
         if (b[t] == c)
            return t;
      }
      // { R: c is not in b[h..k-1] }
      return k;
   }
}
```

9

Two-dimensional arrays

	0	1	2	3
b	5	4	7	3

b.length

one-dimensional array

d	0	1	2	3
0	5	4	7	3
1	4	8	9	7
2	5	1	2	3
3	4	1	2	9
4	6	7	8	0

rectangular array: 5 rows and 4 columns

Type of d is **int**[][] ("**int** array array",
"an array of **int** arrays")

To declare variable d:

int d[][].

To create a new array and assign it to d:

d= **new int**[5][4];

To reference element at row r column c:

d[r][c]

number of rows

number of cols

10

Assignment A5 Mozart's Musikalisches Wuerfelspiel

Uses a two-dimensional array initializer.

Column number (in 1..16): a measure in the piece.
Row number (in 1..6) –choose 1 at random

Use 1 of these for measure 15

```
private final static int[][] trio= {
  {0,  0, 0, 0,  0,  0, 0,  0,  0,  0, 0,  0,  0,  0,  0,  0,  0},
  {0, 72,  6, 59, 25, 81, 41, 89, 13, 36,  5, 46, 79, 30,  95, 19, 66},
  {0, 56, 82, 42, 74, 14,  7, 26, 71, 76, 20, 64, 84,  8,  35, 47, 88},
  {0, 75, 39, 54,  1, 65, 43, 15, 80,  9, 34, 93, 48,69,  58, 90, 21},
  {0, 40, 73, 16, 68, 29, 55,  2, 61, 22, 67, 49, 77, 57, 87, 33, 10},
  {0, 83,  3, 28, 53, 37, 17, 44, 70, 63, 85, 32, 96, 12, 23, 50, 91},
  {0, 18, 45, 62, 38,  4, 27, 52, 94, 11, 92, 24, 86, 51, 60, 78, 31}};
```

For measure 1, roll a die and get a number in 1..6, say 4.

Then, play musical phrase trio[4][1] = 40 for measure 1.

11

Assignment A5 Mozart's Musikalisches Wuerfelspiel

Each integer represents a file name. Example:

trio[3][16] = 21 represents file name waves/T21.wav

```
private final static int[][] trio= {
  {0,  0, 0, 0,  0,  0, 0,  0,  0,  0, 0,  0,  0,  0,  0,  0,  0},
  {0, 72,  6, 59, 25, 81, 41, 89, 13, 36,  5, 46, 79, 30,  95, 19, 66},
  {0, 56, 82, 42, 74, 14,  7, 26, 71, 76, 20, 64, 84,  8,  35, 47, 88},
  {0, 75, 39, 54,  1, 65, 43, 15, 80,  9, 34, 93, 48,69,  58, 90, 21},
  {0, 40, 73, 16, 68, 29, 55,  2, 61, 22, 67, 49, 77, 57, 87, 33, 10},
  {0, 83,  3, 28, 53, 37, 17, 44, 70, 63, 85, 32, 96, 12, 23, 50, 91},
  {0, 18, 45, 62, 38,  4, 27, 52, 94, 11, 92, 24, 86, 51, 60, 78, 31}};
```

For measure 1, roll a die and get a number in 1..6, say 4.

Then, play musical phrase trio[4][1] = 40 for measure 1.

12